Tropical Zoology, 2025
Vol. 38 | Issue 3-4 | 99-110 | doi:10.4081/tz.2025.223

Seasonal shifts in olive baboon (*Papio anubis*) activity budgets at Kainji Lake National Park, Nigeria: adaptive strategies in a changing environment

Funmilayo Lewiska Oni,[1] Delagnon Assou,[2*] Gbolagade Akeem Lameed,[3] Neil D'Cruze,[4,5] Giovanni Amori,[6,7] and Luca Luiselli[2,6,8]

[1]Department of Wildlife and Ecotourism Management, Faculty of Renewable Natural Resources, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria; [2]Laboratory of Ecology and Ecotoxicology, Department of Zoology and Animal Biology, Faculty of Sciences, University of Lomé, Lomé, Togo; [3]Department of Wildlife and Ecotourism Management, Faculty of Renewable Natural Resources, University of Ibadan, Ibadan, Oyo State, Nigeria; [4]Wildlife Conservation Research Unit (WildCRU), Department of Biology, University of Oxford, Tubney House, Tubney, Oxfordshire,UK; [5]Department of Natural Sciences, Manchester Metropolitan University, Manchester, UK; [6]Institute for Development, Ecology, Conservation and Cooperation, Rome, Italy; [7]Research Institute on Terrestrial Ecosystems (CNR-IRET), Rome, Italy; [8]Department of Applied and Environmental Biology, Rivers State University, Port Harcourt, Nigeria

Received: 19 May 2025; Accepted: 25 September 2025.

Abstract: Understanding the activity budgets of primates is essential for assessing behavioral adaptations to environmental changes. This study investigates the seasonal variation in activity budgets of olive baboons (*Papio anubis*) in Kainji Lake National Park, Nigeria. Data were collected over two consecutive years using direct observations and scan sampling to categorize behaviors (including feeding, grooming, resting, locomotion, and social interactions). We observed that feeding remained the dominant activity across seasons, with no significant differences between wet and dry periods. Grooming and social interactions declined during the wet season, likely due to environmental constraints such as heavy rainfall. Enforced resting increased significantly in the wet season, while movements remained consistent in duration but increased in distance traveled, suggesting seasonal behavioral shifts in response to resource availability. Our results document the adaptability of olive baboons in response to climatic variations, demonstrating behavioral flexibility to optimize energy expenditure and foraging efficiency. Our study also reveals a remarkable impact of environmental variables, such as temperature and precipitation, on primate activity patterns. Understanding these adaptive responses is crucial for conservation planning, particularly as climate change, habitat disturbances and other anthropogenic activity affect primate habitats in tropical savannahs.

Key words: Primates; activity budget; seasonality; tropical Africa; Guinea savannah.

*Corresponding author. E-mail: patricedelagnon@gmail.com

Introduction

Activity budgets of primates are fundamental to understanding behavioral adaptations, as primates modulate their behavior in response to seasonal and climatic variations (Campos and Fedigan 2009; Dunbar et al. 2009; Guan et al. 2018). Environmental variables, including temperature, precipitation, and water availability, can significantly influence daily activity budgets and habitat utilization. For instance, cold conditions may restrict home range sizes, while extreme heat can promote shade-seeking behavior and reduces foraging time (Dunbar 1992; Hill 2005, 2006; Abie et al. 2017). Understanding these adaptive responses is critical for primate conservation, as seasonal fluctuations can shape behavioral strategies, distribution patterns, extirpation and extinction risks (Dunbar et al. 2009; Korstjens et al. 2010; Struhsaker 2010; Lambert 2011).

Primate activity budgets vary across taxa, with different groups, such as colobines, cercopithecines, and hominoids, displaying distinct temporal allocations to key behaviors. One of the primary determinants of activity patterns is diet, with frugivorous primates generally allocating more time to feeding and locomotion, and less time to resting compared to folivorous species (Richter et al. 2013; Hendershott et al. 2016; Bach et al. 2017; Ruppert et al. 2018; Yap et al. 2019; Oni et al. 2024). This is the case of the colobines which devote significant time to resting due to the low energy yield of their diet, highlighting how food availability and distribution influence movement patterns and social structures (Dunbar et al. 2009; Fashing 2011; Jung et al. 2015; Klass 2020; Arseneau-Robar et al. 2020). In contrast, cercopithecines, which have more generalized and omnivorous diets, exhibit greater behavioral flexibility in their activity allocation (Dunbar 1992; Ajayi et al. 2020). Their foraging strategies are closely linked to the nutritional quality of available food resources (Riley 2008; Kumpan et al. 2019). For example, baboons (*Papio* spp.) tend to modify their activity budgets in response to thermal stress, increasing resting periods during high temperatures while balancing this with their foraging requirements (Korstjens et al. 2010). In extreme heat, where prolonged resting can constrain energy intake, behavioral adaptations such as crepuscular foraging—feeding during dawn and dusk—may enhance survival (Hill 2006).

Social factors also play a crucial role in shaping primate time budgets. Chimpanzees (*Pan troglodytes* (Blumenbach, 1775)) and gorillas (*Gorilla* spp.) exhibit complex social behaviors, including tool use and intricate social interactions, which significantly influence their daily routines (Hill et al. 2003). Furthermore, primates residing in human-disturbed environments demonstrate altered activity budgets compared to those in undisturbed forests, with changes in foraging behavior, rest periods, and social interactions driven by anthropogenic pressures (Krebs and Davies 1993; Mey Boudoug et al. 2025). Environmental stressors can also disrupt social cohesion and group dynamics, impacting resource acquisition, competition, and mating strategies (Maurice et al. 2020).

Baboons (*Papio* spp.) are considered to be among the most ecologically adaptable primates, occupying diverse habitats across Africa and exhibiting substantial behavioral plasticity in response to seasonal changes, resource availability, and environmental pressures (Hill 2005; Melle and Lameed 2018). Previous studies indicate that high temperatures can reduce foraging activity and increase resting behaviors to mitigate heat stress, while prolonged rainfall can limit movement and enforce extended periods of inactivity (Hill 2006; Joseph 2016).

In the present study, we focus on a population of olive baboons (*Papio anubis* (Lesson, 1827)) in a protected Guinea savannah habitat in Nigeria, aiming to analyze the seasonal influences on activity budgets. Specifically, we aimed to answer the following research questions:

1. How do seasonal variations in rainfall and temperatures affect the activity budgets of olive baboons?
2. To what extent are baboon movements influenced by the rainfall patterns (i.e. by the wet versus dry seasons)?
3. Can we indirectly establish whether resource availability during different seasons shape movement patterns and foraging behavior?

Materials and methods

Study area

Kainji Lake National Park is located in the North central part of Nigeria, at 9°50'19"N and 4°34'24"E (Figure 1). More specifically, we carried out the study in Borgu sector of Kainji Lake National Park (KLNP), located in Niger and Kwara States with an area of 3,970.02 km^2. The park's two sectors (Borgu and Zugurma) are located between 9°57'55.9"N 4°09'05.0"E and 9°43'35.3"N 4°55'27.2"E. The two sectors cover a total area of 5,340.82 km^2 and are separated by the Kainji Lake (Aremu et al. 2000; Oni et al. 2024).

The park has two different seasons, namely, wet and dry season. The wet season occurs from April to October and is marked by an average monthly rainfall of 134.43±95.23 mm, along with high vegetation productivity; and the dry season, lasting from November to March, characterized by minimal to no rainfall (5.40±12.07 mm) and low vegetation productivity (Oni et al. 2024). Annual rainfall in the park ranges between 975 mm and 1,220 mm (Ayeni 2007). While temperatures remain relatively stable throughout the year, they tend to rise starting in January, peaking in March/April (average monthly temperature: 37.68±2.95°C), and then decline with the onset of the rains, reaching their lowest point in August (average monthly temperature: 23.4±2.82°C) (Oni et al. 2024). The park is managed by the federal government

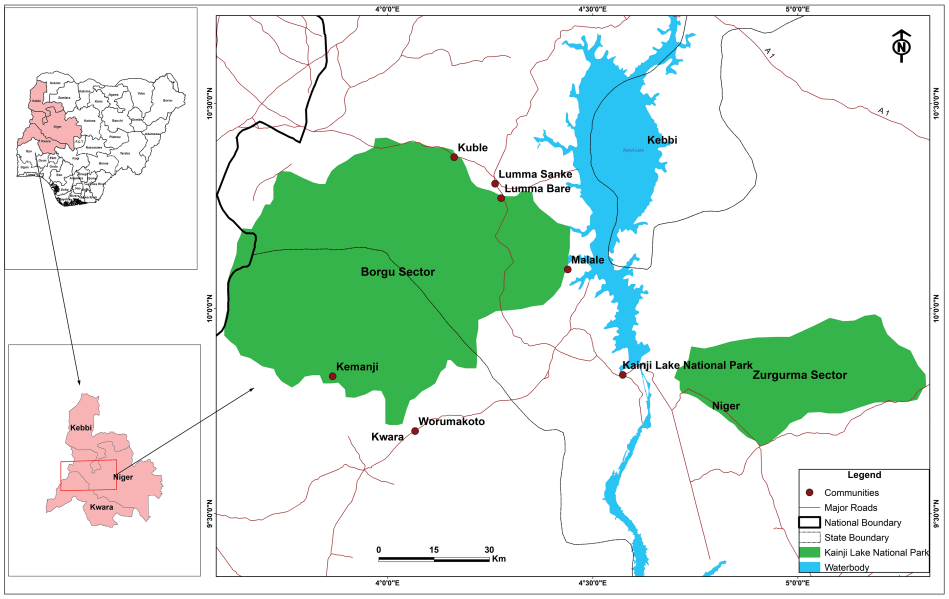

Figure 1. Map of Kainji Lake National Park (source: Oni et al. 2024).

and is surrounded by several human communities, with some as close as less than three kilometers. It remains open to tourists year-round, with peak visitation occurring during festive periods and the dry season, when wildlife sighting is generally higher (Oni et al. 2024).

Protocol

Direct observations of *Papio anubis* troops were conducted daily between 06:30 and 18:00 h for two weeks each month during both the wet (April–October) and dry (November–March) seasons over two consecutive years (2017 and 2018) (Oni et al. 2024). Observations followed the scan sampling method (Eustace et al. 2015), in which two observers systematically recorded the predominant activity of the baboon troop at regular time intervals.

Random searches were conducted along predetermined jeep tracks—Gilbert Child Track (GC), Hussain Mashi Track (HM), and Shehu Shagari Track (SS)—to locate and track baboon troops. Jeep tracks were chosen as starting points due to the increased likelihood of baboon sightings along these routes, facilitating efficient observational studies.

The observed behaviors were categorized into feeding, grooming, free resting, enforced resting, locomotion, and social interactions (Korstjens et al. 2010; Joseph 2016; Abu et al. 2018), even when baboons were at a distance from the roads. Behavioral classifications were as follows:

- Feeding: any activity involving the consumption of food and taking water.
- Grooming: the process in which one baboon removes ectoparasites or debris from another.
- Free resting: voluntary resting periods not influenced by external factors.
- Enforced resting: resting periods imposed by adverse environmental conditions such as extreme temperatures, heavy rainfall, or flooding.
- Locomotion: time spent in directed movement, including walking and running, when no other activity (e.g., feeding, grooming, or social interaction) is observed in most group members.
- Social behavior: interactive activities between individuals, such as mating, playing, playful biting, chasing, or other affiliative and agonistic interactions.

Upon encountering a troop, focal observations were conducted continuously for 15 minutes (Eustace et al. 2015; Fashing 2001; Fernandez-Duque 2003). If an activity lasted for less than 15 minutes, observations were recorded based on the actual duration of engagement in the activity (Oni et al. 2024). To minimize observational biases caused by sudden or simultaneous behaviors at the time of sighting, behavioral recording commenced approximately five seconds after locating a troop (Eustace et al. 2015). When direct observation of the baboon troop was obstructed by dense vegetation, indirect survey methods were employed (Oni et al. 2024). Indicators such as food remnants, footprints, and fecal droppings were documented as alternative measures of baboon activity. Feeding was identified from food remains (e.g., fruits, leaves), resting was recorded when no such evidence was found, and continuous movement without feeding signs was classified as locomotion.

Data analysis

Both descriptive and inferential statistical analyses were performed. Frequency distribution analysis was utilized to determine the percentage allocation of activity budgets during the wet and dry seasons by using the non-parametric Mann-Whitney U test. This test was selected to compare two independent groups (wet and dry seasons) when the dependent variable—measured in hours or minutes—was either ordinal or continuous but not normally distributed. The analyzed behaviors (feeding, grooming, free resting, enforced resting, move-

ment, and social interactions) were introduced in the analysis as dependent variables. Statistical significance was set at $p \leq 0.05$, with all tests being two tailed. In the text, means are followed by ±1 Standard Deviation.

Results

Feeding was the most frequently observed behavior, accounting for 36% of the total activity budget in both seasons, with 523 recorded instances in the dry season and 530 in the wet season (Table 1). Grooming exhibited a seasonal decline, decreasing from 9% (135 occurrences) in the dry season to 6% (89 occurrences) in the wet season. The interseasonal differences fell just short of statistical significance (Table 2). Enforced resting increased

Table 1. Distribution of olive activity budget for wet and dry season, in terms of within-season percentage (and standard deviation).

Activity budget	Wet season	Dry season
Feeding	36%±6.43	36%±4.53
Grooming	6%±2.19	9%±2.19
Enforced rest	27%±0.07	15%±0.07
Free rest	5%±0.28	8%±2.19
Moving	20%±2.9	19%±0.49
Social behavior	6%±1.48	13%±0.35
Distance travelled	132±1.9 km	98.6±0.8 km

Table 2. Mann-Whitney U test results for the activity budget of olive baboons during the wet and dry season.

Activity budget	Season	N	Mean rank	Sum of ranks	P-Value
Feeding	Dry	30	30.35	910.50	0.950
	Wet	30	30.65	919.50	
	Total	60			
Grooming	Dry	30	34.68	1040.50	0.060
	Wet	30	26.32	789.50	
	Total	60			
Enforced rest	Dry	30	22.90	687.00	0.001*
	Wet	30	38.10	1143.00	
	Total	60			
Free rest	Dry	30	31.98	959.50	0.510
	Wet	30	29.02	870.50	
	Total	60			
Moving	Dry	30	29.08	872.50	0.533
	Wet	30	31.92	957.50	
	Total	60			
Social behavior	Dry	30	38.37	1151.00	0.000*
	Wet	30	22.63	679.00	
	Total	60			
Distance travelled	Dry	30	23.10	693.00	0.001*
	Wet	30	37.90	1137.00	
	Total	60			

**Significantly different.*

significantly, rising from 15% (219 occurrences) in the dry season to 27% (408 occurrences) in the wet season, whereas free resting decreased from 8% (120 occurrences) to 5% (79 occurrences). Movement remained relatively stable, constituting 19% (276 occurrences) of activity in the dry season and 20% (291 occurrences) in the wet season. Social behavior declined considerably, dropping from 13% (189 occurrences) in the dry season to 6% (92 occurrences) in the wet season. Additionally, the distance traveled by baboons varied between seasons, with an average of 98.6 km (±1.9) recorded during the dry season and 132 km (±0.8) during the wet season (Table 1). Statistical details of the behavioral differences between baboons' seasons are presented in Table 2.

Discussion

General considerations

In general, our study focused on the seasonal (wet and dry) influences on the activity budgets of olive baboons but did not assess specific environmental conditions, which may also significantly affect their activity patterns. In addition, although tourism activities occur throughout the year in the park, our study did not include anthropogenic factors, which may also impact olive baboon activity patterns. Despite these limitations, we believe that our findings represent valuable information that can be used to help inform future efforts to protect primates in protected Guinean savannahs of West Africa.

Our findings demonstrate that olive baboons prioritized their activities in the following order: feeding, movement, enforced rest, social behavior, and free rest. This pattern mirrors findings made from previous studies on baboon activity budgets in Gashaka Gumti National Park in Nigeria (Joseph 2016), Ndarakwai ranch in Tanzania (Conway 2009), and South of the Rift Valley at Indetu in Ethiopia (Abu et al. 2018). However, notable differences can be observed when compared to other primates, such as long-tailed macaques (*Macaca fascicularis* (Raffles, 1821)), where movement dominates daily activity budgets (Mohammad and Wong 2019). These variations may stem from factors such as habitat type, food availability, and social organization. Previous studies have also shown that macaques in anthropogenic environments exhibit different movement patterns compared to conspecifics from more natural environments which travel greater distances in search of food (McKinney 2011; Hockings et al. 2012; Sha and Hanya 2013).

Feeding behavior and seasonal stability

Our results revealed that feeding was the most dominant activity in the olive baboon's daily routine. Contrary to expectations, seasonal variation appeared to have no significant effect on feeding behavior, as baboons spent comparable amounts of time feeding during both wet and dry seasons. This suggests dietary flexibility, allowing baboons to exploit a variety of available resources year-round. Indeed, this characteristic has already been referred to in previous studies (Joseph 2016). Olive baboons' ability to incorporate a wide range of food sources into their diet (Oni et al. 2024) ensures nutritional stability across seasons, reinforcing their status as highly adaptable foragers (Abu et al. 2018; Joseph 2016). However, protecting diverse habitats that support year-round food availability is therefore crucial for olive baboons' conservation in the Kainji Lake National Park.

Grooming and social behavior

Grooming, a key aspect of primate sociality, exhibited a slight seasonal shift. Although falling short of statistical significance, grooming was more prevalent during the

dry season, a trend that contrasts with findings in Gelada baboons (*Theropithecus gelada* (Ruppel, 1835)) (Abu et al. 2018). The increase in grooming observed during the dry season may be attributed to more favorable weather conditions, allowing for prolonged social interactions (Bronikowski and Altmann 1996; Alberts et al. 2005; Alberts 2019). Conversely, the decline in grooming during the wet season suggests that environmental constraints, such as persistent rainfall at the study area, may reduce the necessity or feasibility of social bonding activities (Alberts 2019). Field observations indicated that grooming was particularly intense when food was scarce, particularly in the late dry season (January–March) (Oni et al. 2024), suggesting a social function beyond hygiene, such as tension reduction and reinforcing group cohesion (Hambali et al. 2012; Abu et al. 2018; Alberts 2019).

Social behavior exhibited a pronounced seasonal decline, decreasing from 13% in the dry season to 6% in the wet season. As mentioned above, this reduction may be linked to heavy rainfall, which likely limits opportunities for group interactions (Hanya et al. 2011; Abie et al. 2017). Baboons were frequently observed seeking shelter under tree canopies during intense rainfall, restricting social engagement. In the dry season, prolonged grooming sessions may also serve a thermoregulatory function, mitigating heat stress (Grow et al. 2014).

Impact of seasonal variation on resting and movements

Enforced rest increased significantly during the wet season, likely due to prolonged rainfall, which restricted movement and, perhaps, foraging efficiency (although the activity budgets for feeding were grossly similar between seasons). Similar patterns have been documented in other primates, where inclement weather leads to increased inactivity (Hill 2005). While voluntary (free) rest showed a minor seasonal decline (from 8% in the dry season to 5% in the wet season), this variation may be attributed to temperature fluctuations. Unlike nocturnal species, olive baboons spend minimal time resting unless environmental factors impose constraints (Mohammad and Wong 2019).

Movement patterns remained relatively stable across seasons in terms of time allocation (19% in the dry season vs. 20% in the wet season). However, travel distance differed significantly, with baboons covering higher distances during the wet season. We suggest that baboons traveled longer distances in the wet season in response to increased food availability (Oni et al. 2024). Similar trends have been observed in primates exploiting seasonally patchy food resources, with greater travel distances linked to higher-quality foraging opportunities (Kanamori et al. 2010).

Restricted movements in the dry season may be an energy-conserving strategy (Whiten et al. 1991), particularly when food resources are limited to gallery forest areas with perennial water sources (Johnson et al. 2015). In this regard, it should be mentioned that fruits have a high relevance in the diet of the local baboon population both in dry and in wet season (Oni et al. 2024), and fruit trees are often displaced nearby water sources. However, this pattern was not observed in Gelada baboons, which maintain more extensive ranging behavior despite seasonal constraints (Abu et al. 2018).

Seasonality, environmental stressors, and conservation implications

Our results are consistent with previous research indicating a strong correlation between rainfall and food availability in primates (Gonzalez-Zamora et al. 2014). Increased moisture during the wet season supports plant growth, providing a diverse array of food sources (Chaves and Bicca-Marques 2016). While some food resources persist beyond the wet season,

seasonal fluctuations still influence foraging behavior. Rainfall had a greater restrictive effect on baboon activity than temperature; while high temperatures prompted baboons to seek shade, rainfall disrupted multiple activities, including movement, feeding, and grooming. Abie et al. (2017) reported similar findings, demonstrating that enforced rest due to rainfall reduces feeding time and food diversity access.

These seasonal behavioral shifts have important ecological and conservation implications. Climate change, habitat fragmentation, and increased human disturbances could exacerbate environmental stressors, further influencing baboon activity patterns. Understanding how baboons adapt to seasonal fluctuations may be useful for conservation planning, particularly in regions facing unpredictable climatic changes. Incorporating long-term behavioral monitoring into conservation efforts can provide valuable insights into population health, habitat use, and adaptive responses — supporting more informed and responsive management practices.

Overall, conservation strategies must consider both ecological and behavioral responses to seasonal changes and human-induced stressors to ensure the long-term viability of primate populations.

Conclusions

Our study contributes to a deeper understanding of how seasonality influences primate behavior, focusing on adaptive strategies that have not been extensively examined in the study area (Lameed 2008; Ikpa et al. 2011; Adeola et al. 2014; Joseph 2016; Odebiyi 2017; Ajayi et al. 2020). As also showed by earlier analyses, our study describes the dynamic nature of baboon activity, emphasizing the role of seasonality in shaping behavioral strategies. Future research should explore the long-term impacts of climate variability as well as the anthropogenic effect on olive baboon populations and their activity budgets, with a focus on habitat management and conservation interventions necessary for sustaining primate populations in increasingly unpredictable environments.

Authors' contributions

FLO and GAL designed the study and conducted the data collection. FLO, DA, ND'C, GA and LL processed and analyzed the data. The initial draft of the manuscript was written by FLO and DA. All contributing authors actively engaged in revising and reaching consensus on the final version for publication.

Conflict of interest

The authors declare no potential conflict of interest.

Funding

None.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Acknowledgements

We sincerely appreciate the management and staff of the Kainji Lake National Park for granting us permission to carry out our research within the park and for accommodation provided during fieldwork. Special thanks to the park guards, especially Mr Kolo and Mr Hammed, for their assistance, which significantly enhanced this work. Finally, we sincerely thank the two anonymous reviewers for their insightful comments on the submitted draft.

References

Abie K, Bekele A, Mekonen A. 2017. Daily activity, feeding ecology and habitat association of Gelada baboon (*Theropithecus gelada*) around Debre-Libanos, Northwest Shewa Zone, Ethiopia. *International Journal of Biodiversity and Conservation*. 9(6):232–238. https://doi.org/10.5897/IJBC2017.1080

Abu K, Mekonnen A, Bekele A, Fashing PJ. 2018. Diet and activity patterns of Arsi geladas in low-elevation disturbed habitat south of the Rift Valley at Indetu, Ethiopia. *Primates*. 59(2):153–161. https://doi.org/10.1007/s10329-017-0640-9

Adeola AJ, Apapa AN, Adeyemo AI, Alaye SA, Ogunjobi JA. 2014. Seasonal variation in plants consumption pattern by foraging Olive Baboons (*Papio anubis* Lesson, 1827) inside Kainji Lake National Park. *Journal of Applied Sciences and Environmental Management*. 18(3):481–484.

Ajayi SR, Ejidike BN, Ogunjemite BG, Olaniyi OE, Adeola AJ. 2020. Population status of olive baboon *Papio anubis* (Lesson, 1827) in Kainji Lake National Park, Nigeria. *Journal of Research in Forestry, Wildlife and Environment*. 12(2):270–276. http://www.ajol.info/index.php/jrfwe

Alberts SC. 2019. Social influences on survival and reproduction: Insights from a long-term study of wild baboons. *Journal of Animal Ecology*. 88(1):47–66. https://doi.org/10.1111/1365-2656.12887

Alberts SC, Hollister-Smith JA, Mututua RS, Sayialel SN, Muruthi PM, Warutere JK, Altmann J. 2005. Seasonality and long-term change in a savanna environment. In: Schaik CV, Brockman DK, editors. Seasonality in Primates: Studies of living and extinct human and non-human Primates. Cambridge Studies in Biological and Evolutionary Anthropology. Cambridge, United Kingdom: Cambridge University Press. p. 157–195.

Aremu OT, Elekhizor BT, Likita IB. 2000. Rural people awareness of wildlife resources conservation around Kainji Lake National Park, Niger State. *Roan: The Journal of Conservation*. 1:80–87.

Arseneau-Robar TJM, Changasi AH, Turner E, Teichroeb JA. 2020. Diet and activity budget in *Colobus angolensis ruwenzorii* at Nabugabo, Uganda: Are they energy maximizers? *Folia Primatologica.* 92(1):35–48. https://doi.org/10.1159/000511046

Ayeni JSO. 2007. Participatory management plan in Kainji Lake National Park. Lagos: Environ-Consult. 156 pp.

Bach TH, Chen J, Hoang MD, Beng KC, Nguyen VT. 2017. Feeding behavior and activity budget of the southern yellow-cheeked crested gibbons (*Nomascus gabriellae*) in a lowland tropical forest. *American Journal of Primatology.* 79(8):e22667.

Bronikowski AM, Altmann J. 1996. Foraging in a variable environment: weather patterns and the behavioral ecology of baboons. *Behavioral Ecology and Sociobiology*. 39:11–25. https://doi.org/10.1007/s002650050262

Campos FA, Fedigan LM. 2009. Behavioral adaptations to heat stress and water scarcity in white-faced capuchins in Santa Rosa National Park, Costa Rica. *American Journal of Physical Anthropology*. 138:101–111. https://doi.org/10.1002/ajpa.20908

Chaves OM, Bicca-Marques JC. 2016. Feeding strategies of brown howler monkeys in response to variations in food availability. *PLOS One*. 11(2):e0145819. https://doi.org/10.1371/journal.pone.0145819

Conway K. 2009. Stand by me: A study of activity budgets, nearest neighbor, social behavior, and home range of the olive baboons *(Papio anubis)* of Ndarakwai Ranch. Independent Study Project (ISP) Collection, 765. 25 pp. https://digitalcollections.sit.edu/isp_collection/765

Dunbar RIM. 1992. Time: a hidden constraint on the behavioural ecology of baboons. *Behavioral Ecology and Sociobiology*. 31:35–49. https://doi.org/10.1007/BF00167814

Dunbar RIM, Korstjens AH, Lehmann J. 2009. Time as an ecological constraint. *Biological Reviews*. 84(3):413–429. https://doi.org/10.1111/j.1469-185X.2009.00080.x

Eustace A, Kisingo A, Kahana LW, Lyimo EH. 2015. Activity patterns of black-and-white Colobus monkey (*Colobus guereza caudatus*) in Rau forest reserve, Tanzania. *Research & Reviews: Journal of Ecology and Environmental Sciences*. 3(4):17–24.

Fashing PJ. 2001. Activity and ranging patterns of guerezas in the Kakamega Forest: intergroup variation and implications for intragroup feeding competition. *International Journal of Primatol*ogy. 22:549–577.

Fashing PJ. 2011. African colobine monkeys: Their behavior, ecology, and conservation. In: Campbell CJ, Fuentes A, MacKinnon KC, Bearder SK, Stumpf RM. editors. Primates in Perspective (2nd edition). Oxford: Oxford University Press. p. 203–220.

Fernandez-Duque E. 2003. Influences of moonlight, ambient temperature, and food availability on the diurnal and nocturnal activity of owl monkeys (*Aotus azarai*). *Behavioral Ecology and Sociobiology*. 54:431–440. https://doi.org/10.1007/s00265-003-0637-9

Gonzalez-Zamora A, Arroyo-Rodríguez V, Escobar F, Rös M, Oyama K, Ibarra- Manríquez G, Chapman CA. 2014. Contagious deposition of seeds in spider monkeys' sleeping trees limits effective seed dispersal in fragmented landscapes. *PLOS One*. 9(2):e89346. https://doi.org/10.1371/journal.pone.0089346

Grow NB, Gursky-Doyen S, Krzton A. 2014. High altitude primates. New York, NY: Springer. 360 pp. https://doi.org/10.1007/978-1-4614-8175-1

Guan ZH, Ma CY, Fei HL, Huang B, Ning WH, Ni QY, Jiang XL, Fan PF. 2018. Ecology and social system of northern gibbons living in cold seasonal forests. *Zoological Research*. 39(4):255–265.

Hambali K, Ismail A, Md-Zain BM. 2012. Daily activity budget of long-tailed macaques (*Macaca fascicularis*) in Kuala Selangor Nature Park. *International Journal of Basic & Applied Sciences*. 12(4):47–52.

Hanya G, Stevenson P, van Noordwijk M, Te Wong S, Kanamori T, Kuze N, Aiba S, Chapman CA, van Schaik C. 2011. Seasonality in fruit availability affects frugivorous primate biomass and species richness. *Ecography*. 34(6):1009–1017. https://doi.org/10.1111/j.1600-0587.2010.06775.x

Hendershott R, Behie A, Rawson B. 2016. Seasonal Variation in the Activity and Dietary Budgets of Cat Ba Langurs (*Trachypithecus poliocephalus*). *International Journal of Primatology*. 37:586–604. https://doi.org/10.1007/s10764-016-9923-z

Hill R. 2005. Day length seasonality and the thermal environment. In: Brockman DK, van Schaik CP., editors. Seasonality in primates: Studies of living and extinct human and non-human primates. Cambridge, UK: Cambridge University Press. p. 197-213.

Hill RA. 2006. Thermal constraints on activity scheduling and habitat choice in baboons. *American Journal of Physical Anthropology*. 129(2):242–249. https://doi.org/10.1002/ajpa.20264

Hill RA, Barrett L, Gaynor D, Weingrill T, Dixon P, Payne H, Henzi SP. 2003. Day length, latitude and behavioural (in)flexibility in baboons (*Papio cynocephalus ursinus*). *Behavioral Ecology and Sociobiology.* 53:278–286. https://doi.org/10.1007/s00265-003-0590-7

Hockings KJ, Anderson JR, Matsuzawa T. 2012. Socioecological adaptations by chimpanzees *Pan troglodytes verus*, inhabiting an anthropogenically impacted habitat. *Animal Behaviour.* 83(3):801–810. https://doi.org/10.1016/j.anbehav.2012.01.002

Ikpa TF, Amonum JI, Agera SIN. 2011. Behavioural patterns of a troop of olive baboons (*Papio anubis*) foraging on maize crops at the borders of Gashaka Gumti National Park Nigeria. *Journal of Research in Forestry, Wildlife and Environment*. 3(2):85–91.

Johnson C, Piel AK, Forman D, Stewart FA, King AJ. 2015. The ecological determinants of baboon troop movements at local and continental scales. *Movement Ecology*. 3:1–13. https://doi.org/10.1186/s40462-015-0040-y

Joseph J. 2016. Activity budgets of olive baboon (*Papio anubis* F.) at Gashaka Gumti National Park, Nigeria. *Journal of Research in Forestry, Wildlife and Environment.* 8(2):74–87.

Jung L, Mourthe I, Grelle CE, Strier KB, Boubli JP. 2015. Effects of local habitat variation on the be-

havioral ecology of two sympatric groups of brown howler monkey (*Alouatta clamitans*). *PLOS One*. 10(7):e0129789. https://doi.org/10.1371/journal.pone.0129789

Kanamori T, Kuze N, Bernard H, Malim TP, Kohshima S. 2010. Feeding ecology of Bornean orangutans (*Pongo pygmaeus morio*) in Danum Valley, Sabah, Malaysia: a 3-year record including two mast fruitings. *American Journal of Primatology*. 72(9):820–840. https://doi.org/10.1002/ajp.20848

Klass KM. 2020. Black howler monkey *(Alouatta pigra)* demography and behaviour in unprotected forest fragments around Palenque National Park, Chiapas, Mexico. PhD Thesis, Graduate Department of Anthropology and the School of the Environment, University of Toronto. 182 pp.

Korstjens AH, Lehmann J, Dunbar RIM. 2010. Resting time as an ecological constraint on primate biogeography. *Animal Behaviour*. 79(2):361–374. https://doi.org/10.1016/j.anbehav.2009.11.012

Krebs JR, Davies NB. 1993. An introduction to behavioral ecology. Oxford: Blackwell Scientific Publications. 420 pp.

Kumpan LT, Rothman JM, Chapman CA, Teichroeb JA. 2019. Playing it safe? Solitary vervet monkeys (*Chlorocebus pygerythrus*) choose high-quality foods more than those in competition. *American Journal of Primatology*. 81(7):e23002. https://doi.org/10.1002/ajp.23002

Lambert JE. 2011. Primate nutritional ecology: Feeding biology and diet at ecological and evolutionary scales. In: Campbell CJ, Fuentes A, Mackinnon KC, Panger M, Bearder SK, Stumpf R., editors. Primates in perspective. Oxford: Oxford University Press. p. 512–522.

Lameed GA. 2008. Poly-specific association of the olive baboon (*Papio anubis*) group within home range in Gashaka Gumti national park. *Ife Journal of Science*. 10(1):91–95.

Maurice ME, Gildas OAF, Ekale BN, Fawoh JJ. 2020. The activity budget of adult chimpanzees (*Pan troglodytes troglodytes*) and environmental conditions in Mefou Primate Sanctuary, Centre Region, Cameroon. *Asian Journal of Research in Zoology*. 3(1):13–25.

McKinney T. 2011. The effects of provisioning and crop-raiding on the diet and foraging activities of human-commensal white-faced capuchins (*Cebus capucinus*). *American Journal of Primatology*. 73(5):439–448. https://doi.org/10.1002/ajp.20919

Melle EM, Lameed GA. 2018. The social daily activity correlation of olive baboon (*Papio anubis*) in Gashaka-Gumti National Park, Nigeria. *Annals of Ecology and Environmental Science*. 2(1):23–28.

Mey Boudoug JC, Dewang Dyio S, Fotie CN, Etah Kang J, Ndzana I, Nguimdo Vouffo VR, Mbolo MM. 2025. Preliminary evidence of great apes' occurrence in peri-urban and highly degraded forest reserves in Cameroon. *African Journal of Ecology*. 63(2):e70022. https://doi.org/10.1111/aje.70022

Mohammad M, Wong A. 2019. The daily activity budgets of long-tailed macaque (*Macaca fascicularis*) at Padang Teratak Wildlife Sanctuary, Beaufort, Sabah, Malaysia. *Journal of Tropical Biology and Conservation.* 16:165–183.

Odebiyi BR. 2017. Crop raiding activities of olive Baboon in Kainji Lake National Park. PhD thesis, University of Ibadan, Ibadan.

Oni FL, Assou D, Lameed GA, D'Cruze N, Kulik L, Luiselli L. 2024. Effect of seasonal variation on feeding and food preference of olive baboons (*Papio anubis*) in a protected Guinean savannah of West Africa. *Mammalia*. 88(6):487–494.

Sha JCM, Hanya G. 2013. Diet, activity, habitat use, and ranging of two neighboring groups of food-enhanced long-tailed macaques (*Macaca fascicularis*). *American Journal of Primatology*. 75(6):581–592. https://doi.org/10.1002/ajp.22137

Richter C, Taufiq A, Hodges K, Ostner J, Schülke O. 2013. Ecology of an endemic primate species (*Macaca siberu*) on Siberut Island, Indonesia. *SpringerPlus*. 2:137. https://doi.org/10.1186/2193-1801-2-137

Riley EP. 2008. Ranging patterns and habitat use of Sulawesi Tonkean macaques (*Macaca tonkeana*) in a human-modified habitat. *American Journal of Primatology.* 70(7):670–679. https://doi.org/10.1002/ajp.20543

Ruppert N, Holzner A, See KW, Gisbrecht A, Beck A. 2018. Activity budgets and habitat use of wild southern pig-tailed macaques (*Macaca nemestrina*) in oil palm plantation and forest. *International Journal of Primatology*. 39:237–251. https://doi.org/10.1007/s10764-018-0032-z

Struhsaker TT. 2010. The red colobus monkeys: variation in demography, behavior, and ecology of endangered species. Oxford: Oxford University Press. 349 pp.

Whiten A, Byrne RW, Barton RA, Waterman PG, Henzi SP. 1991. Dietary and foraging strategies of baboons. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*. 334(1270):187–197. https://doi.org/10.1098/rstb.1991.0108

Yap JL, Ruppert N, Rosely FN. 2019. Activities, habitat use, and diet of wild dusky langurs (*Trachypithecus obscurus*) in different habitat types in Penang, Malaysia. *Journal of Sustainability Science and Management*. 14:71–85.